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BIMONTHLY PROGRESS REPORT

SPACECRAFT SYSTEMS ANALYSIS PROJECT

NAS 9-12330

15 September 1973

Prepared for
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHNSON SPACE CENTER
HOUSTON, TEXAS

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Approved by


V. R. Widerquist, Manager
Spacecraft Systems Analysis
Project

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1. INTRODUCTION

This document is the thirteenth Progress Report submitted by TRW Systems to the NASA Johnson Space Center to report progress on the Contract NAS 9-12330 for the Spacecraft Systems Analysis Project. It represents the status of the work accomplished for the months of July and August 1973.

The task write-ups contain details of task progress including the current progress, major deliverables, problems, and a description of the work to be performed.

Table 1. SSAP Task Status

<u>Task Number</u>	<u>Title</u>	<u>JSC Task Monitor</u>	<u>TRW Task Manager</u>	<u>Period of Performance</u>	<u>Status</u>
E-5H	Problem Definition and Special Studies	J. F. Deluth	V. R. Widerquist	1 July 73 31 December 73	Completed
ASPO-6L	Data Exchange, Data Control Support, & Operations Analysis Support for the Apollo and Post-Apollo Program	J. R. Sevier	G. L. Christen	26 August 72 23 February 73	
E-9K	Communication Systems Analysis	G. D. Arndt	R. J. Panneton	1 July 73 31 December 73	Completed
ASPO-30F	Apollo SSA Project Support	E. L. Tribble	V. R. Widerquist	1 July 72 23 February 73	
ASPO-32J	LM AGS Guidance Software	R. W. Carl	K. L. Baker	26 August 72 26 January 73	Completed
E-34J	Performance Assessment of Spacecraft Radar/Tracking Systems	P. Rozas	E. T. Dickerson	1 July 73 31 December 73	
E-38H	G&C Analysis Requirements and Evaluation	C. S. Finch	J. E. Scheppan	1 July 73 31 December 73	Completed
ASPO-49F	Mission Flight Plan Support	C. L. Stough	R. W. Calvert	1 July 72 31 December 72	
E-53(1)	Antenna & Propagation Studies for Spacecraft Systems	D. S. Eggers	L. H. Robinson	1 July 73 31 December 73	Completed
E-59E	Space Communication Systems Test Analysis	T. E. Ohnesorge	J. C. Miller	8 March 72 30 June 72	
ASPO-61J	Apollo & Post-Apollo Spacecraft Flight Test Planning, Launch Mission Rules, Mission Engineers & Skylab CSM Launch Mission Rules	R. H. Kohrs	W. J. Wylie	26 August 72 23 February 73	Completed

Table 1. SSAP Task Status (Continued)

<u>Task Number</u>	<u>Title</u>	<u>JSC Task Monitor</u>	<u>TRW Task Manager</u>	<u>Period of Performance</u>	<u>Status</u>
E-72E	Guidance, Navigation, and Control Systems Analysis	K. J. Cox	R. Lee	1 July 72 25 August 72	Completed
ASPO-81E	Onboard Data and Crew Procedures Support	T. A. Guillory	M. J. Barone	1 July 72 31 December 72	Completed
ASPO-84B	Skylab Onboard Data and Crew Procedures Support	T. A. Guillory	R. A. Mitchell	1 July 73 31 December 73	
ASPO-88C	Visibility in the Lunar Environment, Lunar Soil Interactions with Surface Experiments, LRV and Engine Plumes	J. R. Sevier	M. J. Barone	26 August 72 26 January 73	Completed
ASPO-89B	Apollo Mission Techniques Development	P. C. Shaffer	C. R. Skillern	1 July 71 30 June 72	Completed
ASPO-90E	Apollo Systems Analysis and Integration	L. G. Williams	R. T. Cliffe	26 August 72 26 January 73	Completed
ASPO-92	Apollo Spacecraft Operational Data Management System Analysis	J. W. Mistrot	B. C. Hopkins	1 July 71 3 December 71	Completed
ASPO-93C	Skylab Mission Flight Plan Support	W. M. Anderson	J. R. Owens	1 July 73 31 December 73	
E-96C	Skylab Service Module Thermal Analysis	R. G. Brown	B. B. Welch	1 July 73 31 December 73	
E-98C	Apollo Service Module Cryogenic Systems Analysis	W. E. Simon	R. K. Seto	26 August 72 29 December 72	Completed
E-99B	Propulsion System Performance Analysis	F. D. Freeburn	R. K. Seto	26 August 72 30 June 73	Completed
ASTP-E101A	Control Systems Analysis	K. L. Lindsay	R. W. Rountree	1 January 73 31 December 73	

Table 1. SSAP Task Status (Continued)

<u>Task Number</u>	<u>Title</u>	<u>JSC Task Monitor</u>	<u>TRW Task Manager</u>	<u>Period of Performance</u>	<u>Status</u>
ASTP-E102A	Service Module Thermal Analysis	R. G. Brown	B. D. Welch	1 July 73 31 December 73	
ASTP-103A	ASTP Spacecraft Flight Test Planning, Launch Mission Rules, Mission Engineers, Data Exchange, Data Control Support, & Operations Support	R. H. Kohrs	W. J. Wylie	1 July 73 31 December 73	
ASTP-104	Mission Flight Plan, Flight Data File and Procedures Support	E. B. Pippert	R. W. Calvert	1 January 73 31 December 73	
ASTP-105	ASTP SSA Project Support	G. H. Parker	V. R. Widerquist	1 February 73 31 December 73	
ASTP-E106	Antenna and Propagation Studies for ASTP	D. S. Eggers	L. H. Robinson	1 January 73 31 December 73	
ASTP-E107	Communication Systems Analysis for ASTP	G. D. Arndt	R. J. Panneton	1 January 73 31 December 73	
KA-201(I)	Skylab SSA Project Management Support	A. A. Bishop	V. R. Widerquist	1 July 73 31 December 73	
KM-202E	Staff Support to Mission Office	A. R. White	O. E. Fayard	1 July 71 31 December 71	Completed
KM-203(I)	Support to Mission Planning and Documentation	A. R. White	V. A. Schweitzer	1 July 73 31 December 73	
KM-204(I)	Weights and Performance Support	W. E. Gotsch	J. A. Drummond	1 January 73 30 June 73	Completed
KM-205J	Skylab Guidance, Navigation, & Control Systems Analysis & Integration Studies	T. P. Lins	R. D. Miller	1 July 73 31 December 73	

Table 1. SSAP Task Status (Continued)

<u>Task Number</u>	<u>Title</u>	<u>JSC Task Monitor</u>	<u>TRW Task Manager</u>	<u>Period of Performance</u>	<u>Status</u>
KM-207G	Operational Data Management for Skylab	M. A. Collins, Jr.	E. M. Wheeler	1 January 73 30 June 73	Completed
KM-212H	Skylab Mission Techniques Development	F. C. Littleton	C. R. Skillern	9 April 73 30 June 73	Completed
251	Operational Data Management/ Weights and Performance Support for Skylab	M. A. Collins, Jr.	B. R. Ellison	1 July 73 31 December 73	
601F	Apollo Science Requirements Support	W. F. Eichelman	J. D. Fuller	26 August 72 30 June 73	Completed
701C	Thermal-Structural Design Analysis for Advanced Manned Spacecraft Systems	E. W. Stephens	G. M. Korb	1 July 71 25 February 72	Completed
702C	Aerodynamic Design Analysis for Advanced Manned Spacecraft	J. C. Young	J. F. Yoder	1 September 72 30 September 72	Completed
703A	Advanced Missions Guidance, Navigation, and Control Systems Requirements and Analysis	C. F. Lively	R. Lee	1 July 71 31 March 72	Completed
704A	Advanced Vehicle Test Require- ments and Planning	C. F. Wasson	J. E. Scheppan	1 July 71 30 July 71	Completed
706A	Advanced Spacecraft Navigation and Landing Tracking Systems Evaluation	J. C. Lamoreux	L. L. Huggins	1 July 71 25 February 72	Completed
707A	Communication Studies for Ad- vanced Spacecraft Systems	H. C. Kyle	R. W. Bains	25 March 72 30 September 72	Completed
709A	Development of a Flexible Spacecraft Simulation Program	C. F. Lively	R. Gluck	1 July 71 1 October 71	Completed

Table 1. SSAP Task Status (Continued)

<u>Task Number</u>	<u>Title</u>	<u>JSC Task Monitor</u>	<u>TRW Task Manager</u>	<u>Period of Performance</u>	<u>Status</u>
711A	POGO Stability Studies of Selected Space Shuttle Con- figurations	A. C. Mackey	A. Rasumoff	1 July 71 30 June 72	Completed
712A	Habitability Data Handbooks	C. D. Council	L. E. Wood	1 July 71 30 July 71	Completed
716	Checkout and Verification of the Flexible Spacecraft Simulation Program	K. L. Lindsay	D. J. Ness	4 December 72 31 August 73	
803	Support for the Shuttle Avionics Integration Laboratory	D. G. Wiseman	M. Fox	7 May 73 31 December 73	

Table 2. SSAP MTS Overtime Hours

<u>Period</u>		<u>Apollo ASPO</u>	<u>Skylab</u>	<u>ASTP</u>	<u>Shuttle</u>	<u>Total SSAP</u>	<u>SSAP Cumulative</u>
FY72	Total for year	367				367	367
FY73	Total for year	634	1379	346	49	2408	2775
FY74	July		47	120	28	195	2970
	August		791	119	21	931	3901

2. REVIEW OF SKYLAB TASKS

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TASK E-5H, PROBLEM DEFINITION AND SPECIAL STUDIES

1. Task Objectives

To provide a quick reaction capability for high priority problem areas affecting the manned spacecraft programs in terms of problem definition and, when appropriate, short-term solutions.

2. Status and Plans

No subtask activities were performed under this task during this report period.

3. Documentation Transmitted to JSC During the Report Period

None

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TASK E-9K, COMMUNICATION SYSTEMS ANALYSIS

1. Task Objectives

The objectives of this task are to support the Avionics Systems Engineering Division of JSC in

- a) Assessing the performance of Skylab spacecraft-to-ground communication systems
- b) Analyzing anomalies and deficiencies encountered in the performance of spacecraft-to-ground communication systems
- c) Developing improved communications techniques for the Skylab space missions

2. Status and Plans

In mid-July, the "Skylab-3 (CSM-117) Mission Communication Systems Performance and Coverage Predictions - Required vs. Expected RF Signal Levels (Trajectory - Independent Data)" report was completed and officially distributed. This document contains data which summarizes the RF link communications capabilities and nominally expected performance for the SL-3 mission. Shortly before the scheduled printing date, a decision was made by EJ5 to change some of the downlink modulation indices from specification values to measured values. Instead of delaying publication of the document, it was decided to proceed with the scheduled printing but to re-submit the two computer programs, which generate receiving thresholds and expected received signal power levels, to determine the effect of the parameter changes. The computer programs required only small modifications and the effects on the tabulated values in the document (caused by the parameter changes) were quickly determined. Since the effect of the parameter changes on the tabulated values was found to be significant, a note was added to the document. The note indicated the quantitative effects of the modulation index changes on the tabulated thresholds and expected received carrier power levels.

An error analysis of a two-way doppler range rate technique for tracking user spacecraft based on a North American Rockwell tracking and data relay satellite system design configuration was completed.

Specifically, the study is an error analysis of the user spacecraft range rate with respect to the tracking and data relay satellite (TDRS). The study is based on the following guidelines and assumptions:

- a) The North American Rockwell (NAR) configurations for the TDRS, ground station, and typical user spacecraft are assumed.
- b) NAR parameter values are used if available.
- c) Only a medium data rate user spacecraft is considered.
- d) The S-band communication link between the TDRS and user spacecraft is assumed.

The North American Rockwell TDRS final report presented a medium data rate (MDR) user range rate tracking error requirement of less than 0.6 cm/sec for a one second integration time and obtained a capability of about 0.1 cm/sec for a one-way doppler technique based on a VHF user/TDRS links. This study indicates a range rate tracking error of about 0.1 cm/sec for a two-way doppler technique based on an S-band user/TDRS link. Thus, the accuracy of the two-way technique considered is essentially the same as the North American Rockwell one-way technique capability.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
73:7153.6-101 (73:7153.6-102)	Progress Report, Task E-9J, for the Month of June, 1973	29 June 1973
20029-H198-R0-00 (73:7153.6-109)	Skylab-3 (CSM-117) Mission Communication Systems Per- formance and Coverage Pre- dictions	July 1973
73:7153.6-125 (73:7153.6-126)	Progress Report, Task E-9K for the Month of July, 1973	2 August 1973
73:7153.6-139 (73:7153.6-141)	Two-way Doppler Range Rate Error Analysis	27 August 1973

TASK E-34J, PERFORMANCE ASSESSMENT OF SPACECRAFT
RADAR/TRACKING SYSTEMS

1. Task Objectives

The objectives of this task are as follows:

- a) To support the Tracking and Communications Development Division (TCDD) of JSC in the evaluation and prediction of the performance of spacecraft radar/tracking systems utilizing TRW generated mathematical models. This performance assessment will include system evaluation, preflight predictions and postflight data evaluation to verify the system performance.
- b) To provide the subsystem manager with a quick reaction capability to evaluate the effects of performance deviations and anomalies with respect to mission requirements.

2. Status and Plans

Several questions have arisen concerning modification of the LM RR to operate in the skin track mode. The basic thrust of these questions concerns the spectrum of the signal with ranging tones and PRF and the effect of target scintillation on the spectrum and on system performance.

The means for evaluation of these and other questions concerning system performance are already available at JSC and require a minimum of time and expense to utilize. A method to resolve some of these questions was described in TRW IOC 73:7153.6-110, dated 5 July 1973. This effort will continue when power is made available to the LM Radar Van.

The modification of the Lunar Module Rendezvous Radar for operation in a non-cooperative skin track mode requires that the ranging tones be demodulated in a noncoherent manner. Currently under investigation is a means to assess the amount of phase noise on the returned ranging tones. This phase "jitter" is expected to be caused by target flutter and the non-linear, noncoherent signal processing in the receiver.

The key to this investigation is the assumption that the comb filter, limiter and discriminator, taken as a whole, comprise a non-linear element which may create products at or near the ranging tone frequencies which will manifest themselves as an apparent phase noise on the

ranging tones. This noise may cause a ranging ambiguity.

The approach to the problem has been two-fold. The preliminary investigation consists of a simulation in which a simulated return IF frequency signal with ranging tone is processed in the proposed manner with a filter, limiter, and discriminator. The demodulated tone is then filtered and phase compared with the original modulating tone. Simulated target "noise" and path noise are added to the return signal.

The second avenue of approach is an analytical investigation of the instantaneous frequency and phase response of the system. Experimental results will be used to validate this investigation.

3. Documenation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
73:7153.6-98 (73:7153.6-99)	Task E-34(I) Monthly Progress Report for the Period 1 June 1973 to 31 June 1973	3 July 1973
73:7153.6-110 (73:7153.6-113)	Use of LM Test Vans to Simulate Modified RR Skin Track Signals	9 July 1973
73:7153.6-134 (73:7153.6-135)	Task E-34J Monthly Pro- gress Report for the Period 1 July 1973 to 31 July 1973	22 August 1973

TASK E-38H, G&C ANALYSIS REQUIREMENTS AND EVALUATION

1. Task Objective

The objective of this task is to support the Avionics Systems Engineering Division of JSC in definition of guidance, navigation and control (GN&C) requirements and the evaluation of the GN&C systems for Skylab missions.

2. Status and Plans

The principal activities performed during this report period were:

- a) MER monitoring of CSM launch and active periods of SL-1/3. Collected real time GN&C systems data for mission report.
- b) Provided 24-hour MER support during RCS quad failure.
- c) Submitted SL-1/2 IMU alignment summary.
- d) Submitted SL-1/3 preliminary IMU alignment and maneuver summary.

The next report period will be utilized to update the CMC downlink telemetry processing plan if required, and continued support of the SL-1/3 mission.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
(73:7153.5-113)	IMU Alignment Summary	2 July 1973
73:7153.5-118	Earth Orbit Insertion Errors for the SL-2 CM-IMU	18 July 1973
(73:7153.5-144)	Preliminary SL-1/3 IMU Alignment and Maneuver Summaries	21 August 1973

TASK E-53(I), ANTENNA AND PROPAGATION STUDIES
FOR SPACECRAFT SYSTEMS

1. Task Objective

The objective of this task is to support the Tracking and Communications Development Division in the following antenna and propagation areas:

- a) Evaluate the performance of spacecraft and EVA antenna systems for the environment in which they are to be used.
- b) Evaluate planned scientific and engineering experiments where antenna and propagation systems are involved.
- c) Perform assessments of VHF, S-band and other links between spacecraft and between spacecraft and EVA.
- d) Evaluate and predict the performance of the Skylab VHF ranging antenna systems.

2. Status and Plans

A report covering the final preflight assessment of the VHF ranging coverage of the rendezvous portion of the SL-1/3 mission scheduled for launch on 28 July 1973 was issued. The data in this report is based on a nominal attitude trajectory, which has the Saturn Workshop (SWS) in a solar inertial (SI) attitude throughout the rendezvous and the CSM terminal phase initiation (TPI) maneuver nominal. Although similar to the trajectory used in the quick-look assessment (June report period), this refined trajectory contains more data points and has smoother transitions before, during, and after the burn maneuvers. As noted in the preliminary SL-3 VHF ranging coverage study, the availability of VHF ranging coverage is very sparse, because throughout most of the rendezvous sequence the CSM antenna is looking at the side and/or rear of the SWS, instead of at the front (where the SWS helix antenna gain is concentrated).

It was concluded that during the latter part of the rendezvous, ranging coverage would not become available until essentially TPI. The plots of received power versus elapsed time indicate that the received power level is varying rapidly with mission time. This phenomenon, together

with the fact that VHF ranging acquisition is expected no earlier than TPI, were the basis for consideration of alternate (and possibly more favorable) trajectory cases. Two representative alternate TPI conditions were selected for study: one representing an early TPI condition (10 minutes earlier than the nominal TPI) and the other a late TPI (10 minutes later than nominal).

An addendum to the preflight SL-1/3 VHF ranging coverage report was issued. This report, dated 25 July 1973, concluded that the time of acquisition for the final tracking period occurs at approximately the same g.e.t. for the early, nominal, and late TPI trajectory cases and that the SWS antenna gain (beamwidth) effects predominate, indicating that SWS attitude is the controlling factor in determining at which g.e.t. the final acquisition will occur.

While preparing for the nominal preflight SL-4 ranging system performance assessment, Task 53 was asked to consider a possible rescue mission, where the SL-4 CSM would rendezvous with the SWS while the SL-3 CSM was still docked at the axial port; the SL-4 CSM would use the radial port. Antenna patterns are not presently available for the SWS VHF helix as occulted by a docked CSM, so the usual type of performance assessment was not undertaken. However, geometrical considerations indicate that the main beam of the SWS helix will be blocked by a docked CSM to the extent that the long range performance of the VHF ranging system should be severely degraded. Under these conditions, the ranging system may not become operational until quite late in the rendezvous, possibly too late to provide sufficient coverage prior to the final braking burns. In a possibly acceptable alternate rescue mission, the SL-3 CSM could be jettisoned prior to the time when the SL-4 CSM requires ranging data. In this case, the ranging system performance should be similar to rendezvous cases already studied.

Since the SL-4 rendezvous trajectory is not expected to be available until early September, Task 53 worked with Tasks ASTP-E106 and ASTP-E107 in documenting the math model used for assessing the VHF ranging system performance. This effort consisted primarily of making available to

the other tasks a series of reference documents in which the model is developed and verifying that the model was properly implemented in the computer program.

Task 53 will continue to collect the data necessary for preflight Skylab studies.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
73:7153.6-104 (73:7153.6-103)	Progress Report, Task E-53H for Period 1 June to 30 June 1973	29 June 1973
20029-H203-R0-00 (73:7153.6-116)	Preflight SL-1/3 Skylab VHF Ranging Coverage Report (Nominal TPI)	13 July 1973
20029-H203-R0-01 (73:7153.6-118)	Addendum to Preflight SL-1/3 Skylab VHF Ranging Coverage (Early and Late TPI)	25 July 1973
73:7153.6-122 (73:7153.6-123)	Progress Report, Task E-53I for Period 1 July to 31 July 1973	1 August 1973

TASK ASPO-84B, SKYLAB ONBOARD DATA AND CREW
PROCEDURES SUPPORT

1. Task Objectives

The objectives of this task are

- a) To assist in the development, validation, and updating of assigned portions of the Skylab flight data files (FDF).
- b) To perform as book managers for assigned items within the Skylab FDF.
- c) Assist the Crew Procedures Division (CPD) as required in providing inflight procedures and onboard data for use in training and simulation exercises.
- d) Develop crew training and flight aids associated with the FDF.
- e) Assist the flight data manager by coordinating changes to the FDF.
- f) To provide support as an onboard data representative to work the FDF interface at KSC with the launch preparation activities.
- g) To assist the CPD in the operation of the configuration and change control process which is implemented for the Skylab FDF.
- h) To assist the Flight Planning Branch in coordinating the data requirements and obtaining and updating the data required for development of the FDF.
- i) To assist CPD by reviewing CSM guidance and control procedures documentation for consistency with the primary guidance system software.
- j) Assist CPD to manage the crew procedures documentation system (CPDS) data base.
- k) Provide support to real time mission operations by maintaining FDF reference books for the flight activities officer (FAO) and the staff support room (SSR).

2. Status and Plans

CSM cue cards for SL-3 were published and delivered for training and flight. Support was provided to generate and validate, through simulations, the real time changes and updates to revise the cue cards to

reflect spacecraft systems problems. These revisions included deorbit with less than four SM RCS quads. The SL-3 rescue mission (SL-3R) CSM cue cards were published. Publication of the early (24 September launch) SL-4 CSM cue cards will be accomplished 5 September.

SWS cue cards for SL-3 were published and delivered for training and flight. Changes in requirements expanded the magnitude of the SWS cue card book extensively from the SL-2 book. SWS cue cards for SL-4 were developed and made ready for publication.

The CSM G&C checklist was incorporated into the document processor system (DPS) data base. Using the automated DPS, the checklist was edited and revised to incorporate approved crew procedures change requests (CPCRs). The SL-3R and SL-4 checklist masters were extracted from the DPS on microfilm and sent to print. The checklist will be continuously maintained on the DPS.

Star charts for SL-3 rendezvous and deorbit were published. Included were charts for alternate launch days. The deorbit chart is designed for a specific deorbit after a 59-day mission. Rendezvous and deorbit star charts for SL-3R, with a launch on 19 September and deorbit on 21 September, were published. The early SL-4 rendezvous and deorbit star charts, based on a 24 September launch and a 56-day mission, will be published 3 September. The nominal (9 November launch) SL-4 deorbit star chart will be made to cover a variable deorbit day and is to be published 9 October.

Support was provided to the fabrication, quality control, and changes to the onboard FDF for SL-3. Fit-checks of the CSM cue cards for SL-3 and SL-4 were accomplished. The onboard FDF for SL-3 was delivered for stowage.

The simulations and crew training exercises were supported with current editions of the FDF, including pen and ink changes. Copies of the SL-3 FDF, including real time changes, are currently maintained in the simulators, trainer, the Flight Activity Officer's staff support room, and for the CAPCOM. The SL-3R FDF books are also maintained for training in the simulator. Additionally, the SL-4 FDF is maintained for training. Crew comments derived from simulations are documented

and forwarded to the appropriate FDF book managers.

The daily Flight Crew Operations Problem Board meetings were furnished with supporting data. Flight plans, real time FDF changes, update messages, and other data needed by the Board, are assimilated and delivered every day.

Real time review of voice tape transcripts was initiated for SL-3. The tape transcript data are categorized as defined by a preselected list. The excerpted data are filed according to category and maintained for reading by interested personnel. The complete transcripts are also maintained. This activity will continue through SL-3 and SL-4.

Real time crew procedures changes and comments from simulations are tracked to assure disposition. Records are maintained to show who has the assignment to evaluate the change or comment. The resulting action is recorded and if the result is a crew procedures change to the SL-4 FDF, a crew procedures change request is processed in the change control system.

Operation of the DPS was continued. Training of personnel to use the system was accomplished. Several FDF checklists were modified on the DPS and new management reports generated. A significant portion of the SL-4 FDF will be generated from the DPS.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No.</u> <u>(Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
(73.6523.3-1)	Transmittal of SKYLARK SUMMARY CARDS Rev 2 (8/22/73) Line Negatives	22 August 1973

TASK ASP0-93C, SKYLAB MISSION FLIGHT PLAN SUPPORT

1. Task Objectives

The objectives of this task are

- a) Provide quantitative data relative to the flight planning integrated data base, such as consumables usage, attitude, and communications subsystems analysis.
- b) Support the integration of mission requirements into the data base and comprehensive flight plan timelines in support of Crew Procedures Division (CPD) flight planning efforts.
- c) Support the CPD in coordinating the interface between the flight plan and the flight data file.
- d) Support the mission simulation and in real time. This includes managing all update pads to the crew, supporting the scheduling data base and tracking of mission requirements status.

2. Status and Plans

PADS Task

A number of detailed changes were made in the PADS operators procedures during July, prior to SL-3 launch. Schedules and training to support SL-3 were prepared and implemented.

Statusing Task

Prepared SL-3 baseline status report during July, prior to SL-3 launch.

Provided continuous SL-3 real time support during August.

Section 4 Task

The final version of SL-3 Section 4 was submitted to the customer in early July. A change package was issued early in August after SL-3 launch. The basic SL-4 Section 4 was completed and submitted to the customer late in August.

Numerous changes are in process for SL-4 and will be incorporated in the basic Section 4 as received until publication date. No firm SL-4 flight plan publication date has been set to date.

MOPS/ASP Correlation Task

Provided continuous correlation table maintenance during this report period. Future support will be on an as-required basis only.

CSM Flight Planning Task

Provided timeline for SL-3 launch, rendezvous, docking, entry and EVA.

Provided real time support for SL-3 launch, rendezvous, docking and EVA.

Timelines were also generated for the SL-3 Rescue during early August.

3. Documentation Transmitted to JSC During the Report Period

None

TASK E-96C, SKYLAB SERVICE MODULE THERMAL ANALYSIS

1. Task Objectives

The objectives of this task are to maintain, update, and document the Skylab service module thermal mathematical models (TMM) to perform premission thermal analysis for SL-3 and SL-4 and postmission analysis for SL-2 and SL-3.

2. Status and Plans

Skylab activities during this report period were thermal math model revision and premission thermal analyses and real time thermal support for the SL-3 mission. The Skylab baseline thermal model network and control logic were modified to provide accurate correlation with the SL-2 mission thermal data. The SL-3 thermal analyses provided SM temperature predictions for the various phases of the mission. The results of each analysis were delivered, upon completion, to the NASA task monitor and all thermal related materials required for real time mission support were delivered prior to the launch date. The SL-3 mission is being supported by continuous data monitoring, thermal evaluation, and simulation analyses as required to assess the thermal control system.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
6531.11-73-59 (6531.11-73-60)	Skylab (SL-3) Real Time Monitoring Schedule	23 July 1973
6531.11-73-58 (6531.11-73-60)	Skylab (SL-3) Mission Real Time Data Records	23 July 1973
6531.11-73-42 (6531.11-73-60)	Skylab Real Time Thermal Monitoring - SM Measure- ment Location Reference and Plot Display	11 May 1973 (Updated 25 July 1973)
6531.11-73-57 (6531.11-73-60)	Revised Skylab (SL-3) Real Time Monitoring - SM Temper- ature Limits and Data Displays	23 July 1973

TASK KM-203(I), SUPPORT TO MISSION PLANNING
AND DOCUMENTATION

1. Task Objectives

Support will be provided in the following activities for each mission:

- a) Preparing, coordinating, reviewing, and maintaining the detailed test objectives on experiments, subsystems, and crew/operational tests for incorporation in the mission requirements document (MRD)
- b) Preparing and maintaining the Skylab mission requirements document, including related MRD configuration control activities
- c) Reviewing, reporting on, and contributing to mission and operational documentation, design reviews, and change paper (RECP/PSCN, etc.) to insure consistency and compatibility with mission objectives and requirements
- d) Supporting mission staff engineer and Skylab program office participation in mission planning and MCC activities during the conduct of Skylab missions
- e) Supporting activities on constraints, systems limitations, mission rules, consumable redlines, inputs to launch mission rules, and launch commit criteria
- f) Providing assistance in mission planning problem identification, performing special studies, and resolving action items as directed
- g) Supporting appropriate meetings, panels, and working groups and preparing appropriate reports

2. Status and Plans

A preliminary copy of Change 2 to the SL-3 MRD was delivered on 18 July 1973 including specification change notices (SCNs) 105, 106, 107, 108 and 110, and preliminary specification change notice (PSCN) 141. After PSCN 141 was approved as SCN 109, the reproduction masters and 60 advance copies of Change 2 were delivered on 24 July.

An advance copy of Change 3 to the SL-3 MRD was delivered on 25 July including SCNs 112 and 115, and PSCNs 142, 145 and 146. After PSCNs 142, 145 and 146 were approved as SCNs 114, 116 and 113 respectively, the reproduction masters and 60 advance copies of Change 3 were

delivered on 26 July.

The final (signature) draft of the Apollo telescope mount (ATM) section of the SL-3 MRD was prepared, and 150 advance copies of the section along with reproduction masters were delivered as Change 4 to the MRD.

An advance copy of Change 5 to the SL-3 MRD was delivered on 27 July to include PSCNs 147 through 152. The reproduction masters and 60 advance copies of the final draft Change 5 were delivered on 30 July with the PSCNs assigned SCN numbers 118 through 123.

An advance copy of Change 6 to the SL-3 MRD was delivered on 30 July to include SCN 98 and PSCNs 153 and 154. The reproduction masters and 60 advance copies of the final draft of Change 6 to the SL-3 MRD, I-MRD-001F, Volume II, were delivered on 10 August to include SCNs 98, 124, 125, 126, 127, 128 and 129.

Two advance copies of Change 7 to the SL-3 MRD were delivered on 14 August to include three unapproved PSCNs 161, 163 and 164. After approval of these PSCNs, the reproduction masters and 60 advance copies of Change 7 were delivered on 21 August to include SCNs 130, 131 and 132.

Change 8 to the SL-3 MRD has been in preparation since 21 August. The following PSCNs have been prepared and submitted for approval prior to issuing the change:

<u>PSCN</u>	<u>Title</u>
165	Revisions to ED52, Web Formation
166	Deletion of Science Demonstrations SD1 and SD2
167	Update Video Requirements for SL-4 (Note: This PSCN includes TV setup during the end of SL-3)
169	Still Photography for M092
170	Addition of Motion Sensitivity and Oculogyral Illusion Tests for Experiment M131
171	ED78, Liquid Motion in Zero G
172	Parasol Material

The revised SL-4 MRD was approved at the Level II CCB meeting of 23 August subject to the following changes:

- a) Change of the DTO for M516, Crew Activities/Maintenance Study, back to the draft version of 2 July.
- b) Change of status of DTOs for experiments D024, Thermal Control Coatings, and S020, X-ray/Ultraviolet Solar Photography from "Preliminary" to "Assigned" status.
- c) Deletion of the DTO for 20.19, SLA Deployment Observation.

In addition, DTO 20.20, Parasol Material, was added as a result of approval of SCN 138.

After incorporation of the above changes, the reproduction masters and one copy of the signed version of the SL-4 MRD, 27 August, were delivered.

Change 1 to the SL-4 MRD is in preparation including the following PSCNs:

<u>PSCN</u>	<u>Title</u>
162	Update M518 DTOs
167	Update Video Requirements for SL-4
168	Revision to Photography Requirements for ED61/62
171	ED78, Liquid Motion in Zero G
173	Still Photograph for M092 on SL-4
176	Addition of DTO 20.21, Taste and Aroma Evaluation
179	Increase in Frequency of Monitoring Carbon Monoxide
180	Update of DAC Film Requirements for Student Investigations on SL-3 and SL-4

Additional new DTOs are in preparation for the following SL-4 activities:

20.22	Food Return
20.23	Coolanol Vapor Detection (Note: The title may be changed to Atmosphere Analysis)

174	Increase in Frequency of Measuring Body Mass
175	Deletion of F03 of Experiment S149
177	Additional M509 and M151 Activities
178	S082B Operating Mode Change in BB29
180	Update of DAC Film Requirements for Student Investigations on SL-3 and SL-4

Additional potential PSCNs are in work for Change 8 in response to the following FOMR/mission action requests:

BX-1604	Hemoglobin and urine Specific Gravity
MRD-1776	Additional M151 Coverage of ETC Prep

Eighty copies of the draft of the revised SL-4 MRD, I-MRD-001F, Volume III, were delivered on 2 July to a special distribution list provided by the KM office. Comments received on this draft were reviewed and integrated into the document and three copies of the revised draft were delivered on 22 August. This issue of the document incorporated the following changes into the SL-4 draft MRD of 2 July 1973.

SCN 83	Deletion of Portions of Experiment S083 Covering Operation from the Solar SAL
SCN 101	Revise S183 DTO
SCN 106	Change in Crew Exercise Requirement for SL-3 and SL-4
SCN 107	Student Investigations ED24 and ED25
SCN 113	Changes to S019, ED23 and ED26
SCN 121	Corrections to Experiment T003 DTOs in MRD
SCN 127	Revised S230 Requirements
SCN 129	Revise S191 16-mm Film Type and Film Processing

Deletion of T013, Crew/Vehicle Disturbances

Deletion of T027/S073, Contamination Measurement and Gegenschein/
Zodiacal Light

Deletion of ED11, Atmospheric Absorption of Heat

Review copies of the ATM section of the SL-4 MRD were prepared for use at the ATM Working Group meetings held at JSC on 24 August and 28 August. TRW provided support for both of the above meetings, preparatory to submitting the final draft of the section for Level II CCB approval.

TRW prepared an initial draft of a proposed new section of the SL-4 MRD which will define Experiments S019, S063, S183, S201, T025 and ATM viewing requirements for observing Comet Kohoutek during the SL-4 mission. Support was provided for Kohoutek meetings held at JSC on 16 August and at MSFC on 22 August and 28 August.

Fifty preliminary copies and reproduction masters of Appendix B, Revision B, Earth Resources Requirements, were delivered to the Program Office (KM) on 24 July. This revision incorporated previously issued pen and ink changes to Revision A, plus added requirements submitted and approved under PSCN 144 to the MRD. The revised appendix reflects four new EREP tasks, and an increase in baseline task/sites from 495 in Revision A to 506.

The Skylab Rescue Mission Requirements Document I-MRD-001, Volume IV, was revised during August to reflect, primarily, the added requirements for return experimental data for a potential SL-3/SL-R mission. The reproduction masters and ten advance copies of the rescue document were delivered on 30 August.

The following additional miscellaneous activities were conducted during this report period:

- a) Made a survey for comparison of SL-3 minimum scheduling requirements and performance redlines proposed by NASA Headquarters versus those contained in the SL-3 MRD.
- b) Prepared changes to DTOs for Experiments S019, ED23 and ED26 based on contents of a letter from K. Henize to K. Kleinknecht dated 11 July.
- c) Prepared comments on MSFC ECR PMDP-0380, S150 requirements changes for SL-3 MRD and ECR PMDP-0386, update to M518 DTOs.
- d) Assisted in the definition of requirements for science demonstrations for inclusion in the SL-3 MRD.

- e) Coordinated inputs for the further definition of television requirements for the TV section of the SL-3 MRD and updated the video documentation requirements section for the SL-4 MRD.
- f) Prepared changes to DT0s for ED52, ED63, S230, D024, S020, T025 and 20.15.
- g) Worked with the principal investigator of experiments M487/M516 on potential changes to the DT0s for these experiments on SL-4.
- h) Prepared a summary of major changes to the SL-4 MRD for use by the Skylab Missions Office.
- i) Initiated data changes and errata for the next change to Appendix B, Revision B, Earth Resources Requirements. In addition, the master copy of the EREP ground site list is in the process of updating.

TRW continued to support the Missions Office in Level II MRD configuration control. Processing was accomplished on the following changes:

<u>PSCN</u>	<u>Title</u>
136	General Update of the SL-4 MRD
137	Revised ATM Section for SL-3
138	Change in Crew Exercise Requirement for SL-3 and SL-4
139	Additional Requirements for Experiment T013
140	Updated Skylab Video Documentation Requirements for SL-3
141	Scheduling Guideline Changes (PD43C)
142	Change to SL-3 DT0 for Experiment S063, UV Airglow Horizon Photography
143	Science Demonstrations Requirements for SL-3
144	EREP Change to Mission Requirements Document for SL-3
145	Reduction in Frequency of Measuring Crew Body Mass
146	Changes to S019, ED23, and ED26
147	Clarification of Acceleration Constraints for Experiments M131 and T027/S073

148	T027/S073 Photometer Program Priority List for SL-3
149	Revise T027/S073 Venting Constraint
150	Corrections to Experiment T003 DTOs in MRD
151	Completion of S228 Requirements
152	Changes to EREP Film Requirements for Experiments S190A and S190B
153	Changes to Medical Experiment and Operational DTOs Due to Increase of Mission Duration to 59 Days
154	Deletion of Experiments S009 and S183
155	Addition of Performance Redline Requirement Guidelines
156	Addition On-Orbiting Testing of Experiment T020
157	Revised S230 Requirements
158	Skylab Rescue Vehicle Experiment Return Stowage (SL-3)
159	Change to M131 Return Payload
160	Revise S191 16-mm Film Type and Film Processing
161	Change to ED63, Cytoplasmic Streaming
162	Update M518 DTOs
163	Add Temperature Measurements DTO to SL-3 MRD
164	Deletion of CSM Fly-Around Requirements
165	Revision to ED52, Web Formation
166	Deletion of Science Demos SD1 and SD2
167	Update Video Requirements for SL-4
168	Revision to Photography Requirements for ED61/ED62
169	Still Photography for M092
170	Addition of One Motion Sensitivity and One Oculogyral Illusion Test to Experiment M131

171	ED78 (Liquid Motion in Zero G)
172	Parasol Material
173	Still Photography for M092 on SL-4
174	Increase in Frequency of Measuring Crew Body Mass
175	Deletion of FO 3 of Experiment S149
176	Addition of DTO 20.21, Taste and Aroma Evaluation
177	Additional M509 and M151 Activities
178	S082B Operating Mode Change in BB-29
179	Increase in Frequency of Monitoring Carbon Monoxide
180	Update of DAC Film Requirement for Student Investigations on SL-3 and SL-4 and add ED63 to SL-4
181	Additional M151 Coverage of ETC Preparation
182	Incorporation of S019 AMS into Experiment S063

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
(73.6523.2-94)	General Distribution of Mission Requirements Document, Third Skylab Mission, SL-4, I-MRD-001F, Volume III, dated 2 July 1973	2 July 1973
(73.6523.2-95)	Preliminary Version of Change 2 to the SL-3 Mission Requirements Document, I-MRD-001F, Volume II	18 July 1973
(73.6523.2-96)	Change 2 to the SL-3 Mission Requirements Document, I-MRD-001F, Volume II	24 July 1973
(73.6523.2-97)	Preliminary Copies and Reproduction Masters of Mission Requirements Document, I-MRD-001, Appendix B, Earth Resources Requirements for SL-3, dated July 1973	24 July 1973

(73.6523.2-98)	CCBD/RECP/PSCN 151 for Experiment S228 for SL-3 MRD	25 July 1973
(73.6523.2-99)	Advance Copy of Change 3 to the SL-3 Mission Require- ments Document, I-MRD-001F, Volume II	25 July 1973
(73.6523.2-100)	Change 3 to the SL-3 Mis- sion Requirements Document, I-MRD-001F, Volume II	25 July 1973
(73.6523.2-101)	Change 4 to the SL-3 Mis- sion Requirements Document, I-MRD-001F, Volume II	26 July 1973
(73.6523.2-102)	Change 5 to the SL-3 Mission Requirements Document, I-MRD- 001F, Volume II	30 July 1973
(73.6523.2-103)	Advance Copy of Change 6 to the SL-3 Mission Re- quirements Document, I-MRD- 001F, Volume II	30 July 1973
(73.6523.2-104)	Comments on PSCN 156, Addi- tional On-Orbit Testing of Experiment T020	2 August 1973
(73.6523.2-105)	CCBD/RECP/PSCN 157 for Experiment S230	3 August 1973
(73.6523.2-107)	CCBD/RECP/PSCN 158	8 August 1973
(73.6523.2-108)	Review of ECR PMDP-0386, "Update M518 DTOs"	8 August 1973
(73.6523.2-109)	Change 6 to the SL-3 Mis- sion Requirements Document, I-MRD-001F, Volume II	10 August 1973
(73.6523.2-110)	MSFC ECR PMDP-0383, "Ex- periment D024, Resupply for SL-4"	13 August 1973
(73.6521.2-111)	Advance Copy of Change 7 to the SL-3 Mission Re- quirements Document, I-MRD- 001F	14 August 1973

(73.6521.2-112)	Summary of the Major Changes Incorporated into the August 22, 1973 Issue of the SL-4 Mission Requirements Document, I-MRD-001F, Volume III	17 August 1973
(73.6521.2-114)	TRW Letter 73.6523.2-107, dated 8 August 1973, "CCBD/RECP/PSCN 158"	20 August 1973
(73.6521.2-115)	Change 7 to the SL-3 Mission Requirements Document, I-MRD-001F, Volume II	21 August 1973
(73.6521.2-116)	Signed Version of Mission Requirements Document, Third Skylab Mission, SL-4, I-MRD-001F, Volume III, dated 22 August 1973	27 August 1973
(73.6521.3-1)	SL-R MRD Revision G	30 August 1973

TASK KM-205J, SKYLAB GUIDANCE, NAVIGATION, AND CONTROL
SYSTEMS ANALYSIS AND INTEGRATION STUDIES

1. Task Objectives

The objectives of this task are

- a) To support the Avionics Systems Engineering Division (ASED) of JSC in Skylab-related guidance and control analysis and integration studies
- b) To assist the ASED in support of the Skylab program office in evaluating guidance and control related mission requirements and system performance capabilities

2. Status and Plans

Major activities during the month were directed toward support of the SL-1/3 mission. The docked digital autopilot operations summary was completed and published. Some of the data contained in the document pertinent to the mission are as follows:

- a) Nominal DAP erasable load data for docked OA control
- b) Procedures for control of the OA with a failed CSM RCS quad
- c) DDAP erasables load for a rescue mission
- d) Wide deadband control initiation rates

A portion of the above data was published in the crew checklist and also supplied directly to FCSD.

In support of the SL-1/3 mission, several analytical efforts were pursued during the month. These analyses included the following:

- a) Examination of +X translation under CSM attitude hold mode control.
- b) Quad B failed tests of attitude hold capability (1/2°, 5°, 16° deadbands).
- c) Quads B and D failed tests of attitude hold capability, particularly wide deadband (16°) mode.
- d) Development of special procedures to establish wide deadband rates using couple control in the pitch axis.

- e) Development and verification of erasable loads to allow control of the undocked CSM using the docked DAP. (Special loads are necessary to compensate for mass properties variation due to SPS propellant shift in the tank.)

In addition to the simulator analysis performed, support has been provided to staff the mission evaluation room during critical mission activities involving actual or potential CSM control.

A task work plan for the period from July through December was published, but since the SWS deorbit burn was eliminated, the plan is no longer valid. A preliminary task work plan, reflecting elimination of the SWS deorbit activities, has been prepared for JSC review. Publication will be withheld until the review is completed.

A revised set of erasable loads was prepared for the various possible rescue configurations. This revision was necessitated by mass properties changes resulting from the addition of SPS propellant to the SL-4 vehicle.

Updated simulator results presenting attitude hold propellant consumption data for the nominal and rescue vehicle configurations were documented.

A TVC DAP filter design for controlling the SWS deorbit burn was documented. Since the planned burn has been eliminated, the data is for documentation purposes only, but a significant improvement in control system performance is exhibited by the TRW filter design.

Updates to the docked DAP data contained in the crew checklist for the SL-1/4 mission were provided to FCSD. Formal publication of the data will be made at a later date and incorporated into a general update for SL-1/4.

3. Documentation Delivered to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
(73:7153.5-103)	June Status Report - KM-205	26 June 1973
(73:7153.5-108)	Task KM-205 Work Plan - First Half of FY74	29 June 1973

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
(73:7153.5-110)	SL-3 CSM DDAP Erasables	29 June 1973
(73:7153.5-114)	Reduction of TVC Start Transient for SWS Deorbit Burn	5 July 1973
(73:7153.5-117)	Skylab CSM Attitude Hold Propellant Consumption	23 July 1973
(73:7153.5-119)	Docked DAP Handbook Update for SL-3	20 July 1973
(73:7153.5-125)	TRW Filter Design for Skylab Deorbit TVC DAP	27 July 1973
(73:7153.5-126)	Skylab CSM Attitude Hold Propellant Consumption - Updated Nominal and Rescue	27 July 1973
(73:7153.5-133)	July Status Report - KM-205	6 August 1973
(73:7153.5-134)	SL-1/3 CSM DDAP Erasable Loads for Undocked Control	6 August 1973
(73:7153.5-138)	SL-1/4 R CSM RCS DDAP Rescue Erasable Loads	13 August 1973

TASK 251, OPERATIONAL DATA MANAGEMENT/WEIGHTS
AND PERFORMANCE SUPPORT FOR SKYLAB

1. Task Objective

The objective of this task is to implement and maintain an operational data management function and weight control program for the Skylab program. The function will be implemented and maintained through the Skylab Program Operational Data Group (ODG).

- a) Determine user requirements for the data to support operational activities;
- b) Acquire these data from authoritative sources;
- c) Control the flow of operational data;
- d) Integrate this information to satisfy user requirements;
- e) Disseminate and maintain these data current;
- f) Provide a single authoritative data source for operational activities;
- g) Provide a single authoritative data source for real time activities; and
- h) Collect, verify, and prepare for publication all Skylab weights data required for an effective weight control program.

2. Status and Plans

Spacecraft Operational Data

Task effort during this report period included preparation/publication of update amendments to all five Skylab Operational Data Book (ODB) volumes, acquisition of data for new ODB items, and real time support to the task monitor during launch and conduct of the SL-3 mission. One hundred and thirty amendments to the ODB volumes were published. Support activities included:

Task members attended Configuration Control Board meetings to acquire information on hardware items to be launched on CSM 117.

Task members established JSC interfaces and acquired data on new crew equipment. Four new sections were added to Volume V as a result of this activity.

Task members continued to monitor all mission action requests and coordinate applicable data into ODB updates.

Task personnel supported the task monitor in the conduct of his duties in the Skylab mission evaluation room (MER). Mission action requests were picked up four times daily from the flight operations management room, reproduced, and distributed to the operational data group (ODG) team members in the MER, JSC Building 2, and responsible task subsystem engineers for evaluation and impact to the ODB. Coordination between the ODB managers, ODG contractor data suppliers, and task personnel resulted in the production of amendment changes. The MER was manned, during high activity periods, by ODB personnel to facilitate fast turn-around of real time data which impacted the ODB and to support MER personnel in the acquisition of data needed for real time support.

Task personnel supported the task monitor in the planning and conduct of the On-site Contractors Meeting. Preparation and publication of the minutes to this meeting were accomplished.

During this report period the following updates were published and distributed:

Thirty-four amendment updates to ODB Volume I, Experiments Performance Data.

Twelve amendment updates to ODB Volume II, Mission Mass Properties.

Twenty-seven amendment updates to ODB Volume III, CSM Performance Data.

Forty-two amendment updates to ODB Volume IV, Skylab I Performance Data.

Fifteen amendment updates to ODB Volume V, Crew Equipment Performance Data.

In response to ODG Specification 2, 106 data submittals were received, evaluated and processed as ODB changes.

The operational data exchange received four new data requests and processed six data submittals in response to data requests.

Mass Properties Data

The mass property support for the months of July and August is as follows:

Task 251 mass property personnel monitored the CSM 117 propellant (service propulsion system and reaction control system)

loading from the MER from Friday, 6 July through Sunday, 8 July. These data were incorporated into ODB Volume II, Amendment 13.

Flight Control Division (FCD)/Mission Planning and Analysis Division (MPAD) - Real time CSM mass properties and aerodynamic data based on the daily Flight Crew Integration Division (FCID) current CM stowage status report were supplied to MPAD. These daily reports, along with real time amendments, were primarily used to compute CSM block data for the flight controllers.

Mission evaluation room (MER) - The MER was manned by mass property personnel during mission high activity phases so mass property data could be computed immediately, either upon request or when pertinent configuration changes occurred. Also, daily CSM mass properties and aerodynamics data based on the daily FCID stowage status report were supplied to MER officials. MER and Huntsville Operations Support Center (HOSC) action items were also worked when applicable. These action items were reviewed, tabulated, and incorporated into ODB Volume II when applicable.

As previously reported, significant differences existed between the Operational Data Group and MSFC with respect to the SL-1/4 docked deorbit transformation. This problem was resolved during this report period when it was learned that MSFC was applying a positive 210° rotation when it really should have been a negative 210° rotation.

A prime effort of the group during this report period consisted of supporting the CCB meetings. All CCB meetings were attended and board decisions which affected the vehicle mass properties were incorporated into the data base. A report of approximately 20 pages was then generated for the next CCB meeting. Twenty copies of this report along with view graphs were provided to the task monitor for his presentation to the CCB. This report included the following:

- a) SL-2 (CM 116) return mass properties
- b) SL-3 (CM 117) current mass properties
- c) SL-3 (CM 117) return mass properties
- d) SL-4R (CM 118R) rescue mission launch
- e) SL-4R (CM 118R) rescue mission return
- g) SL-4R (CM 118R) baseline experiments refueled on pallet
- h) SL-4 (CM 118) launch
- i) SL-4 (CM 118) baseline delta weight list
- j) SL-4 (CM 118) launch stowage candidate list
- k) SL-4 (CM 118) launch (aft/bulkhead locker stowage)
- l) SL-4 (CM 118) launch with stowage candidates

The actual weighing of the SL-3 stowage items and the packaging of the lockers were monitored at KSC by one member of the group. These data were then forwarded to Houston to provide JSC with the most current vehicle mass properties.

The following ODB Volume II amendments were completed during this report period:

<u>Amendment No.</u>	<u>Description</u>	<u>Date</u>
11	SL-1/4 Deorbit Mission	5 July
12	SL-1/3 L/D Update	11 July
13	SL-1/3 Update	19 July
14	LEV-TVA/SL-3 TEL	20 July
15	SL-1/4 Update	20 July
16	SL-1/4R and SL-1/5R Update	25 July
17	Actual Consumables Loading	26 July
18	SL-1/3 Update	3 August
19	SL-1/4R (CSM 118R)	14 August
20	Final SL-1/2	20 August
21	SL-1/3 Update	23 August
22	SL-1/4 Update	28 August

Receipt and transmittal of the following mass property computer tapes occurred during this report period.

<u>Receipt</u>	<u>Date of Data</u>	<u>Comments</u>
SL-1/3 Stowage	29 August 1973	This tape was received on 30 August 1973

<u>Transmittals</u>	<u>Date of Transmittals</u>	<u>Comments</u>
MMC Stowage (3)	23 August 1973	Scratch tape forwarded to Martin-Marietta

The transferable equipment list (TEL) effort during this report period has centered around computing the following:

- a) Finalizing SL-2 return stowage
- b) Finalizing SL-3 launch stowage
- c) Finalizing SL-3 return stowage
- d) Finalizing SL-4 (CM 118) launch stowage
- e) Adjusting SL-4 (CM 118) return stowage
- f) Finalizing SL-4R (CM 118R) launch stowage

- g) Adjusting SL-4R (CM 118R) return stowage
- h) SL-2 postflight TEL

TEL personnel generated CM weight and mass property status reports for the above configurations. Two TEL tapes have been received for SL-3 from Martin. The first tape received on 14 August did not include workshop de-activation and therefore could not be used. The second tape, received on 29 August does contain workshop de-activation. The CM 117 launch and return stowage will be updated to reflect the latest CCB actions and these data will be included in the next amendment to Volume II, ODB.

The mass properties data exchange activities are summarized below:

MSC - Vol. II 73-15 (SL-1/4R Update)	Closed
MSC - Vol. II 73-16 (SL-1/4 Update)	Closed
1-H-497 (SPS Target Load for SL-4R/SL-4)	Closed
1-H-498 (CSM-118 Mass Properties - SPS "High")	Closed

It was learned during this report period that differences existed between the ODG and MSFC with respect to food/fecal handling and transfer. This caused not only a difference in weight but also a 1.8 inch difference in Z-bar in the OWS and an overall Z-bar difference of approximately 0.9 inches. The ODG food/fecal analysis was transmitted to MSFC. The problem is pending at this time.

Sixty copies of August Skylab Weight & Performance Report were delivered to the task monitor on 2 August. Considerable effort has been expended in verifying RI actual weight reports for CSM 118 and CSM 119. All discrepancies have been worked and resolved.

Several modifications and additions were made to the mass properties system, (MAPSYS). They are as follows:

- a) Several minor output format changes were made in order to print out additional data to be used for data verification.
- b) Several of the launch abort and re-entry programs were entered on comshare during this report period.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No.</u> <u>(Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
73.6522.4-27	Transmittal of Status Report for the Month of June 1973, JSC/TRW Task KM-207G	6 July 1973
73.6522.4-38	Transmittal of Status Report for the Month of July 1973, JSC/TRW Task 251	10 August 1973

3. REVIEW OF ASTP TASKS

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TASK ASTP-E101A, CONTROL SYSTEM ANALYSIS

1. Task Objectives

The objectives of this task are to support JSC in control system analyses and in the performance evaluation and application of the digital autopilot for the Apollo/Soyuz Test Project (ASTP).

2. Status and Plans

A test plan has been documented for ASTP software testing where the Apollo digital autopilot controls the CSM/DM configuration. The tests are designed to produce results in two areas - performance capability and software verification. To date the testing activity has concentrated on simulator preparation. To accomplish the planned SPS thrust vector control (TVC) testing, considerable time is being spent to incorporate and check out flexible vehicle bending characteristics and structural loads data.

In addition to supporting the Working Group 2 meetings in Moscow in June, support to Working Group 2 has been provided in July and August. The principal activity was reviewing the Soyuz control system test results brought to Houston by Dr. Victor Legostaev, USSR Working Group 2 chairman. Also, the task members have participated in and attended several status reviews conducted by the program director.

From the information transmitted by the Soviet side at the July meeting, an update to the Soyuz control system model was prepared. The model update specified a change in the rate feedback parameter. This value should be incorporated into the Soyuz control system model and used in the subsequent Dynamic Docking Test Simulator (DDTS) activity.

A review has been conducted of ASTP-40500, "Contingency Plan." Although all of the documented comments pertain to control system requirements for the Soyuz and Apollo control systems, the document was reviewed for all the areas of Working Group 2 responsibility.

A work plan has been documented which provides a task schedule for August to December, 1973. The scheduled items comply with the Working Group 2 schedule and the CSM milestone reviews.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
73:7153.5-123 (73:7153.5-127)	Test Plan for CSM/DM for ASTP	27 July 1973
73:7153.5-128	Summary of Recent Working Group 2 Meetings on Control Systems	1 August 1973
73:7153.5-140	Update to Soyuz Control System Rate Feedback Gain	14 August 1973
73:7153.5-145	Review of Contingency Control Requirements	22 August 1973
73:7153.5-142	Task Schedule August to December, 1973	27 August 1973

TASK ASTP-E102A, SERVICE MODULE THERMAL ANALYSIS

1. Task Objectives

The objectives of this task are to utilize the TRW SINDA thermal math models (TMMs) of the service module, developed for analysis of the Apollo and Skylab configuration, to provide thermal performance analysis of the Apollo/Soyuz Test Project (ASTP) SM.

2. Status and Plans

The main activities during this report period were revision of the baseline ASTP thermal model and continued analysis of the thermal design mission. The thermal model was modified to incorporate the network and logic changes made to the Skylab model as a result of model correlation with the SL-2 real time mission data. Model documentation and analytical data will be delivered during the next report period.

3. Documentation Transmitted to JSC During the Report Period

None

TASK ASTP-103A, ASTP SPACECRAFT FLIGHT TEST PLANNING,
LAUNCH MISSION RULES, MISSION ENGINEERS,
DATA EXCHANGE, DATA CONTROL SUPPORT, AND
OPERATIONS SUPPORT

1. Task Objectives

Subtask 103-1

- a) To assist P00 in the evaluation of the adequacy of existing ASTP spacecraft and docking module data to assure that the data will support the intended purpose
- b) To assist P00 in the identification, acquisition, and control of ASTP spacecraft and docking module data required for mission planning
- c) To originate and prepare a monthly weight status report
- d) To originate and prepare mass properties data

Subtask 103-2

- a) To assist in ASTP mission planning with generation and maintenance of related mission requirements documentation
- b) To assist in earth orbital science planning and preparation of related documentation for inclusion in the MRD
- c) To assist in preparation of ASTP launch mission rules
- d) To perform studies for resolution of action items related to operations analysis
- e) To provide flight test mission engineering support to the JSC mission staff engineers

Subtask 103-3

To assist in the technical resolution of ASTP action items resulting from program and/or configuration changes.

Subtask 103-4

Coordination of PI/Author inputs to the Apollo 17 preliminary science report (PSR).

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2. Status and Plans

ASTP Mass Properties General (Subtask 103-1)

Task 103 is continuing its effort to obtain the latest available mass properties. This is being accomplished by monitoring the master change record (MCR) documents, by monitoring CCBd items, and by coordinating its effort through telephone communications with Mr. Carlos Moore of Rockwell International.

The ASTP Weight Status Report is complete except for firm weight data on the experiment candidates. Sources for these weights are being investigated and a current experiment weight status listing should be completed shortly. The computer run to update the stowage list for the status report is complete.

ASTP Mass Properties Operational Data Book (Subtask 103-1)

The primary effort for the past two months has continued to focus on producing an operational data book (ODB) for the ASTP. After resolution of comments on several sections, SSM approval of four new docking module sections, and final signoff by NASA and Rockwell, the ODB was submitted for publication on 17 August. Distribution should be made during the first week in September.

Producing the ODB required coordination by TRW with 22 subsystem managers and other JSC authorities (which involved some 40 separate endorsements) and preparation of over 750 pages of data masters.

The tracking list of outstanding data requirements was updated to reflect additional data requirements, anticipated dates for receipt of NASA supplied data, and receipt of several Rockwell supplied data requirements. Rockwell has not yet supplied predicted dates for their data requirements.

Based upon initial selection of ASTP experiments by NASA, plans have been initiated to obtain and incorporate experiments data into the ODB.

A continuing endeavor during this period has been to monitor Skylab Volume III ODB updates and review other ASTP data sources to obtain

additional data appropriate to ASTP. Five ASTP ODB updates have resulted from this effort.

Launch Mission Rules (Subtask 103-2)

The following is a summary of the activities that were accomplished for the launch mission rules support (Skylab and ASTP).

- a) Issued a final amendment for Volume III, Part 2, concerning redline changes in the sequential, water (potable and waste) and cryo subsystems of CSM-117. The changes were concurred upon by JSC and RI subsystem managers. The changes also were submitted to Flight Control to be incorporated in the Launch Mission Rules Document at KSC.
- b) Based on the maximum liftoff weight of the CSM-117 of 13,500 pounds, the waste and potable water tank redlines were changed to comply with the liftoff weight. A telecon was set up between JSC and KSC personnel to discuss the acceptable redline values. Redline quantities were generated to satisfy liftoff weight, KSC operations, E&D and the launch mission rules. Redline values and rationale were submitted to Flight Control who concurred and the results were incorporated in the Launch Mission Rules Document.
- c) Supported real time final countdown for SL-3 up to liftoff (27-28 July).
- d) Issued a final redline amendment to the following subsystems for Skylab rescue mission: Entry batteries, cryogenics and potable and waste water. The redlines for the rescue mission and the mission dependent redlines guidelines were incorporated as an appendix to Volume III, Part 2, of the Skylab ODB.
- e) Drafted a letter from PA/G. Lunney to FA/Director, Flight Operations, concerning the launch mission rules input to SL-4 and the rescue mission. The input was enclosed in the letter and is to be incorporated in the Launch Mission Rules Document.
- f) Drafted guidelines for mission dependent redlines for SL-4. The guidelines were submitted to Flight Control, E&D personnel and RI for concurrence.
- g) Continued the effort on making a "shopping list" as candidates for downgrading certain components/subsystems from mandatory to highly desirable for a rescue mission. This shopping list is to provide

guidance for management in real time and not to be used as an official sanction.

Mission Support Engineer (Subtask 103-2)

An ASTP announcement of flight opportunity (AFO) was issued to the science community 6 July 1973. Support was provided by suggesting changes to the AFO technical backup material. In response to a request to JSC for more detailed information on the ASTP, the ASTP experimenters information package, originally issued last year, was revised and updated. A chart was prepared for JSC to compare ground station coverage during the pre-rendezvous period for a Skylab mission and ASTP. It was shown that without use of the AST-F relay and USSR coverage, Skylab had two to three times the length of coverage that could be expected by ASTP.

Support was provided to the US/USSR Experiment Working Group discussing the joint experiments and interface engineering documentation. In addition, support was provided to a meeting held at JSC 28 July concerning trajectory problems inherent in the electron beam experiment.

A meeting was held at NASA Headquarters to screen the experiment proposals received in response to the AFO, with TRW supporting JSC personnel. Some 136 proposals were received. Basic information on the experiments was collected and forwarded to support a science review board which met 31 July through 2 August at JSC to recommend a selected group of experiments. The science review board recommended nine primary and ten secondary experiments to the Manned Space Flight Experiment Board (MSFEB) which met 10 August. Assistance was provided in preparing material on the recommended experiments which were presented to the MSFEB.

The MSFEB recommended seven science and application (astronomy and physics) and five life science experiments. Assistance in evaluation of these experiments was provided in discussions with North American Rockwell (NAR) and the principal investigators (PIs). A preliminary timeline and a preliminary TV plan were provided to JSC. Support was provided to a meeting held 27-30 August at NAR to consider interface

problems of the selected experiments.

Subtask 103-3

Action Items

The principal task activities during the July/August 1973 report period were directed toward the technical resolution of action items for the Skylab and ASTP command and service module (CSM). Significant action items included:

- a) Evaluation and assurance that all command and service module/Skylab workshop (SWS) electrical power system (EPS) interface control documents (ICD) and associated actions were properly closed for the SL-1/3 mission.
- b) Evaluation of the SL-1/3 CSM/SWS EPS quiescent mode considering the factors of SL-1/2 experience and SL-3 unique experiments.
- c) Participation in Crew Safety Panel meetings to investigate the ground support equipment (GSE) power relay contactor make anomaly that occurred during SL-2 launch. A complete remake after launch commit would have transferred vehicle power back to ground, and resulted in a launch abort. MSFC and KSC modified the electrical support equipment (ESE) circuits in the GSE to prevent a power transfer after launch commit, and investigation revealed that existing procedures were adequate to cover an instrument unit (IU) loss of power.
- d) An analysis of the effects of and likelihood of contamination in the electro-mechanical devices (switches and relays in particular) used in the ASTP docking module docking system (DS). It was concluded that all the devices, except possibly the DS motor overload protection switch, are adequately screened against contamination. Further, the effects of potential contamination are minimized by virtually complete system redundancy.
- e) A total of eleven request for engineering change proposals (RECPs) and fourteen Skylab operational data book change notices (DCNs) were evaluated and resolved during this report period.

Preliminary Science Report (PSR) (Subtask 103-4)

During the July/August 1973 report period, the subtask activity consisted of the following:

- a) Participation as a member of the PSR Editorial Review Board in the technical review of orbital science inputs to the Apollo 17 PSR.
- b) Coordination of review board comments with orbital science authors, and release of all orbital science sections to Kentron/Hawaii for final grammatical editing.
- c) Submittal of final edited drafts of all orbital science sections to authors for their review.
- d) Coordination (60% complete) of author comments with Kentron/Hawaii preparatory to final submittal to NASA Headquarters for publication.

With the completion of the final item above (within approximately one week) this subtask will be closed.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
(73.6523.4-42)	Task 103-3 - Weekly Status Report and Action Item Log	3 July 1973
(73.6523.4-43)	Task 103-3 - Weekly Status Report and Action Item Log	10 July 1973
(73.6523.4-44)	Task 103-3 - Weekly Status Report and Action Item Log	17 July 1973
(73.6523.4-45)	Task 103-3 - Weekly Status Report and Action Item Log	24 July 1973
(73.6523.4-46)	Task 103-3 - Weekly Status Report and Action Item Log	31 July 1973
(73.6523.4-47)	Task 103-3 - Weekly Status Report and Action Item Log	7 August 1973
(73.6523.4-48)	Task 103-3 - Weekly Status Report and Action Item Log	14 August 1973
(73.6523.4-49)	Task 103-3 - Weekly Status Report and Action Item Log	21 August 1973
(73.6523.4-50)	Task 103-3 - Weekly Status Report and Action Item Log	28 August 1973

TASK ASTP-104, MISSION FLIGHT PLAN, FLIGHT DATA
FILE, AND PROCEDURES SUPPORT

1. Task Objectives

The objectives of this task are to

- a) Integrate mission requirements into a comprehensive flight plan timeline in support of CPD flight planning efforts.
- b) Develop alternate mission profiles for contingencies and delayed launches.
- c) Provide an integrated data base of information relative to consumables usage, attitudes, communications, operations and vehicle/crew systems.
- d) Coordinate the technical/operational requirements by supporting mission meetings/panels and crew briefings.
- e) Support CPD in development and maintenance of the FDF definition and preliminary checklists.
- f) Support CPD in development of the IVA and transfer procedures.

2. Status and Plans

The flight planning team has just completed a third iteration of the joint activities period timeline. Substantial changes were brought about as a result of the recent Russian meetings in July. The timeline is being published and will be sent to Russia ahead of the upcoming meeting in Moscow in October.

A flight plan guidelines document was completed and discussed with the Russians during the July meetings.

Summary timelines for the third, fourth and fifth launch opportunities have been prepared.

Detailed timelines for the fourth and fifth launch opportunities have been prepared.

A sequence and duration of the docking/undocking tests at the conclusion of joint activities has been prepared.

Document 40401 (MCC timeline) has been reviewed to verify compatibility between the two timelines.

Proposals for contingency mission cases have been identified with respect to developing these cases into onboard data.

TV schedules including checks with ground stations have been investigated and are now scheduled in the timeline.

3. Documentation Transmitted to JSC During the Report Period

None

TASK ASTP-E106, ANTENNA AND PROPAGATION STUDIES FOR ASTP

1. Task Objective

The objective of this task is to support the Tracking and Communications Development Division in the following antenna and propagation areas:

- a) Evaluate the performance of the ASTP spacecraft antenna systems for the environment in which they are to be used.
- b) Evaluate the VHF, S-band and other links between the ASTP spacecraft and between the ASTP spacecraft and other spacecraft.

2. Status and Plans

During this period modifications to the VHF computer analysis program, HV014E, were affected and tested out by running with several SL-1/3 trajectory tapes.

A report summarizing the math model used for predicting the performance of the ASTP VHF ranging system was issued, published initially as a USA/USSR working group document and later (with minor revisions) as a TRW report. Condensing the information contained in several documents issued by Tasks E-78 and E-53, this report presents a simplified model for computing the total received power as a function of the combined effects of direct path (line-of-sight) signals and multipath reflected signals.

The simplified model assumes specular reflection from a smooth spherical earth having the electrical properties of seawater. As noted in the reference documents, a more complete rough surface model did not yield significantly different results, so the simplified model was chosen to reduce the required computation time. The model is used to compute the total received power at each of several trajectory time points, using as inputs the spacecraft state vectors and attitude direction cosines.

Work will continue on establishing milestones with the NASA technical monitor and obtaining and reviewing documentation relating to the ASTP mission and VHF systems.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
73:7153.6-106 (73:7153.6-105)	Progress Report, Task ASTP-E106, for the Period 1 June to 30 June 1973	29 June 1973
73:7153.6-124 (73:7153.6-125)	Progress Report, Task ASTP-E106, for the Period 1 July to 31 July 1973	2 August 1973
USA-WG4-352 20029-H207-R0-00 (73:7153.6-136)	Procedure and Assumptions for Estimating VHF Ranging System Performance	29 August 1973

TASK ASTP-E107, COMMUNICATION SYSTEMS ANALYSIS FOR ASTP

1. Task Objective

The objective of this task is to support the Avionics Systems Engineering Division of JSC in

- a) Assessing the performance of the VHF spacecraft-to-spacecraft and spacecraft-to-ground communication systems and the S-band spacecraft-to-ground communication system
- b) Analyzing anomalies and deficiencies encountered in the performance of spacecraft-to-ground and spacecraft-to-spacecraft communications systems
- c) Developing improved communications techniques for the ASTP space missions

2. Status and Plans

Documentation of the results of a preliminary analysis of the effects of multipath interference on VHF communications between the Apollo and the Soyuz spacecraft during the Apollo Soyuz Test Project (ASTP) mission was completed. The Soyuz spacecraft will be equipped with two four-element helices, similar to the Apollo lunar module antennas. These types of antennas make the VHF link susceptible to multipath interference due to earth reflections. Using an ASTP reference trajectory, the available antenna patterns, current transmitter and receiver system parameters, and the existing mathematical models, it is possible to predict the magnitude of received signal power variations caused by earth reflected signals.

From the analysis performed, it is concluded that, for the case of maximum spacecraft-to-spacecraft separation for VHF tracking, the total power received at the Soyuz will vary about the free space value by +1.9 dB and -2.4 dB. For the four other cases considered, where the separation between vehicles is progressively smaller, the range of expected received power variations can be expected to diminish.

During the past two months, considerable effort has been devoted to the proper organization and format of the math models for the VHF and S-band communication links which are to be used in generating ASTP

communication system compatibility test predictions. Coordination has been conducted between TRW, EJ5, and EE7 in order to assure that the proper symbols, nomenclature, and subscripts are being used as agreed upon by the USA and USSR sides. The symbols, equations, and definitions used in the VHF math model are those jointly agreed upon by the USA/USSR teams and consequently some are not in a familiar American form. The S-band communications links, however, are not a joint item and a more familiar form was used in the S-band math model. Assistance was furnished to EJ5 in the preparation of a working group document defining the math models which was sent to Russia for review on 29 August 1973.

3. Documentation Transmitted to JSC During the Report Period

<u>Document No. (Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
73:7153.6-107 (73:7153.6-108)	Progress Report, Task ASTP-E107, for the Month of June, 1973	5 July 1973
73:7153.6-127 (73:7153.6-128)	Progress Report, Task ASTP-E107-1, for the Month of July, 1973	2 August 1973
(73:7153.6-132)	ASTP Compatibility Test Predictions Math Models	(17 August 1973)
73:7153.6-131 (73:7153.6-140)	Preliminary ASTP VHF Multipath Analysis	17 August 1973

4. REVIEW OF END-ITEM TASK

TASK 716, CHECKOUT AND VERIFICATION OF THE FLEXIBLE SPACECRAFT SIMULATION PROGRAM

1. Task Objective

The objective of this task is to check out and verify the Flexible Spacecraft Simulation (FSS) program developed under TRW Task 709.

2. Status and Plans

During the months of July and August 1973, the checkout effort on the Perturbed Motion Program (PMP) of FSSP was continued. Results were obtained using the Flexible Body Dynamics (FBD) routine of FSSP at the NASA Johnson Space Center (JSC) for one rigid-body and four flexible body check cases specified by TRW during the previous report period. The results obtained from the FBD were in agreement with those obtained at TRW using the Three-Body Program (TBCP).

Two flexible appendage verification cases were formulated and delivered to JSC. The first model consisted of a zero-mass, zero-inertia central body to which two identical flexible beams were cantilevered; that is, the system reduced to that of two identical flexible beams cantilevered to one another, or the equivalent of a free-free beam with length equal to twice that of each cantilever. Eigenvalues and eigenvectors corresponding to the first five symmetric modes were computed from the coefficient matrices produced by the TBCP (identical to those produced by the FBD) and they all agreed to within three percent of the theoretically calculated values (the first three eigenvalues agreed to better than 1/2 percent). Time history simulations were run on the second model - consisting of a rigid central body with two flexible appendages - and the results compared favorably with those obtained using the TRW-developed Unified Flexible Spacecraft Simulation Program (UFSSP).

All the above described check cases consider the special situation where the nominal motion of the system is identically zero. Being a particularly important case for perturbational analysis, this zero nominal motion (or fine pointing) case was addressed first in the checkout and verification effort. When non-zero nominal motion was introduced into the model, it was impossible to verify the coefficient

matrices synthesized by the TBCP and the FBD with those produced by LEGUP, an existing TRW computer program that generates the linearized dynamic equations of coupled rigid body systems. By examination of the derivation of the basic FBD dynamic equations and, finally, by telephone contact with the originator of those equations (who has left TRW Systems), it was determined that an error existed in the original formulation of the Flexible Body Dynamics Routine. Since a rederivation of the basic dynamic equations was far beyond the scope of the present verification task, it was decided, by mutual consent of the TRW task manager and the JSC task monitor, to proceed with verification of a zero nominal motion (fine pointing) version of the Perturbed Motion Program.

In order to optimize this fine pointing version of the PMP, the Dynamics-Controls Interface was respecified and delivered to the JSC programmer. In addition, three check cases have been generated and delivered to JSC for checkout and verification of this new Dynamics-Controls Interface. All these check and verification cases have been transmitted informally in order to expedite the verification effort; they will be documented in the final report.

In order to more thoroughly check the PMP, a two-month task extension, at no increase in the total task estimated cost, has been requested. This requested extension has been discussed with the JSC technical monitor, Mr. Kenneth Lindsay, who has indicated his approval of the change.

3. Documentation Transmitted to JSC During the Report Period

None

4. Problems

As indicated under Status and Plans above, existence of an error in the PMP dynamics derivation has been identified which precludes checking out the PMP for non-zero nominal motion. In particular, this means that the verification of the combined Nominal and Perturbed Motion Programs of the FSSP cannot be accomplished under this present task. The existing Nominal Motion Program can still be used as a stand-alone

simulation, as can the fine pointing version of the Perturbed Motion Program presently being verified. A Task 716 Work Statement Amendment to delete Task 3.0 (verification of the combined Nominal and Perturbed Motion Programs of the FSSP) has been submitted to JSC.

5. REVIEW OF SHUTTLE TASK

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TASK 803, SUPPORT FOR THE SHUTTLE AVIONICS
INTEGRATION LABORATORY

1. Task Objective

The objective of this task is to support the Shuttle Avionics Integration Laboratory (SAIL) in definitive planning of the SAIL program.

2. Status and Plans

A significant part of the task activity during the report period has been directed toward helping to organize and supporting a number of working groups and panels planning the SAIL development.

A working group was established to formulate the working agreement between SAIL and the Flight Operations Directorate. A mutually satisfactory agreement has been negotiated, which is awaiting definitization of the Rockwell SAIL support effort to complete the list of milestone dates.

A working group was formed from all SAIL-supporting organizations to prepare the Configuration Management and Quality Control policies, plans and procedures to be used in SAIL. In addition to performing a key role in configuration management planning, TRW has taken the responsibility as coordinator and recorder for the working group.

A new subtask was assigned to TRW to define the preliminary functional requirements for the Flight Dynamics Simulation Complex, which will be part of the SAIL. The results of this study are being coordinated and directed through a working group which will ultimately define and control all SAIL math models.

A data management plan was prepared and submitted. This plan defines the activities which must be performed to define and provide the data processing capability for SAIL. Upon submission of the plan, activity related to data management will be suspended until the SAIL organization role and responsibility for data management become more clearly defined.

Technical support to JSC in preparation for the Shuttle System Requirements Review was provided. Ten documents were reviewed and comments

were submitted to the task monitor.

Progress was made in definition of the documentation for the SAIL. A diagram depicting the facility documentation has met general consensus. A study is now in progress to define how SAIL documentation should be related to Shuttle Program and Orbiter Project documentation and directives. The corollary problem of integrating other element test articles' requirements (propulsion systems, payloads, Launch Processing) into SAIL documentation is also being studied.

The SAIL test requirements as defined by Rockwell in the Avionics System Requirements Definition Document have been revised. An update to the "SAIL Test Requirements" working paper is being prepared reflecting and commenting on these revisions.

Documentation Transmitted to JSC During the Report Period

<u>Document No. Transmittal Letter No.)</u>	<u>Title</u>	<u>Date Published</u>
JSC - (TBD)	Configuration Management Plan for Shuttle Avionics Integration Laboratory (Rough Draft)	21 August 1973
JSC - (TBD)	Documentation Management Plan for Shuttle Avionics Integration Laboratory (Outline and Appendices)	21 August 1973
73:7153.5-156 (73:71530.MF-31)	Data Management Plan Development	31 August 1973